Cover Drive and Lock Ring Mechanisms for Genesis

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The Genesis mission will place a spacecraft outside the Earth's magnetosphere and expose ultra-pure materials to the solar wind for about 23 months. The embedded solar wind samples will be returned to the Earth in the Genesis payload, a canister that is safely contained within the Sample Return Capsule (SRC) for reentry. The canister is rich with mechanisms, containing four distinct assemblies: the Cover Drive Mechanism, the Lock Ring Mechanism, the Array Deployment Mechanism (ADM), and the Array Latch. Two key components, the Cover Drive and Lock Ring Mechanisms are the focus of this paper. These two mechanisms provide straightforward functions: a launch latch and the means to open and close the canister cover, but their requirements and design are linked together creating a much more challenging problem.

Figures 1 and 2 show the integrated canister in both the closed and open configurations. The Cover Drive Mechanism and Lock Ring Drive Mechanism are visible on opposite ends of the canister. The Lock Ring Assembly is located around the perimeter of the canister between the cover and base flanges. Solar wind is captured with both the concentrator and the hexagonal collectors that fill the arrays. The Array Deployment Mechanism (ADM, not visible in the figures) is a stepper motor drive with separate motors used to deploy each of the 4 arrays in the base. The Array Latch secures the stowed arrays for launch and reentry.

The Lock Ring Mechanism consists of the Lock Ring Assembly and the Lock Ring Drive Mechanism. Along with the Canister Seal, this mechanism's purpose in the canister assembly is: to provide a launch latch for the canister cover to sustain launch, reentry, and recovery loads in tension/compression; to prevent contamination of the canister interior; and to produce a push-off force to separate the seal interface. In addition the mechanism must operate in 1g and must be capable of performing a functional test to verify the flight electrical interfaces and actuator operation without opening the canister.

The Lock Ring Assembly consists of an aluminum ring with twenty-four ½-inch-diameter track roller pairs equally spaced around the ring perimeter. The Shuttle Get-Away Special (GAS) design inspired this basic configuration. The upper row of track rollers is mounted on twenty-four flexures that provide a clamping force on the joint created by rolling up ramps to the preloaded position. The clamping force compresses the seal and preloads the joint against launch/reentry forces so that metal-to-metal contact is maintained. Obtaining and maintaining the metal-to-metal contact during launch and reentry was the biggest challenge for the canister structure and lock ring system. This

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feature is a distinct difference between the Genesis payload design and the Shuttle GAS and it is an important difference because of the Genesis need for extreme contamination control. The two flexures located nearest the Array Latch are stiffer in order to react additional inertial loads. Radial bearings at 12 locations around the ring provide both radial alignment capability and radial load capacity. The push-off block provides a separation force at the seal interface when the ring unlocks. Push-off reaction pads capture the Lock Ring Assembly when unlocked and act in conjunction with the push-off and shorting blocks to create the seal separation. The entire Lock Ring Assembly is seen in Figures 1 and 2 but a more detailed view is available in Figures 3a and 3b.

The Lock Ring Drive Mechanism (Figures 4a and 4b) provides torque to lock and unlock the Lock Ring and to operate the Array Latch. The mechanism consists of a dual-wound, electronically-commutated gearmotor with redundant Hall effect rotor position sensors and drive electronics. The gearmotor drives into a pinion and sector geartrain mounted on the Lock Ring. Radial loads from the gear mesh are reacted into the track roller and bearing assembly of the mechanism rather than directly into the Lock Ring to minimize Lock Ring deflection and maintain the correct gear mesh. The mechanism operates by driving into hard stops at the end of travel in each direction until a timeout occurs. Microswitches provide confirmation that the mechanism arrived at the hard stop.

The Cover Drive Mechanism (Figures 5a and 5b) provides torque to open and close the cover also by driving into hard stops at the end of travel in each direction until a timeout occurs. Microswitches again provide confirmation of the event. As with the Lock Ring Mechanism, the Cover Drive must also operate in 1g and must be capable of performing a functional test to verify the flight electrical interfaces and actuator operation without opening the canister. The same gearmotor design used in the Lock Ring Drive Mechanism is used in the Cover Drive Mechanism but in this case the gearmotor drives directly at the cover hinge axis using the hex on the gearmotor instead of the pinion gear. The shaft turns on a spring-preloaded bearing pair. The hinge axis is located at the 0.020-inch seal crown height (i.e. above the metal-to-metal interface between the cover and the seal retainer mounted on the canister). Cover arm flexures permit cover translation when the lock ring engages.

Both mechanisms have interesting design challenges of their own. In the Lock Ring Mechanism, there are tradeoffs between the ramp profile, the torque required to lock the ring, and the lock ring flexure design. An additional tradeoff exists between the capture range of the device and the push-off stroke. In the Cover Drive Mechanism, the design of the cover arm flexures was a particular challenge. However, the most interesting aspect of all is the coupling between the two mechanisms. The location of the Cover Drive Mechanism hinge line plays directly into the capture range of the Lock Ring Mechanism. The hinge line location also makes the cover arm flexures necessary.

The Engineering Model canister has been designed, built, and tested and will be delivered for integration to the EM SRC in mid October 1999. The Flight Model canister will be built and tested during the year 2000 with delivery to the FM spacecraft scheduled for mid July 2000. The work described in this paper has not been published before.

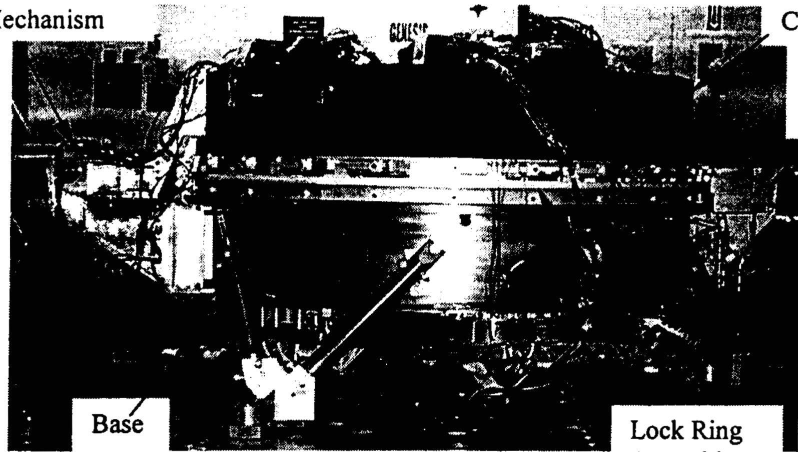


Figure 1. The Engineering Model integrated canister in the **closed configuration** is mounted on its vibration test fixture.

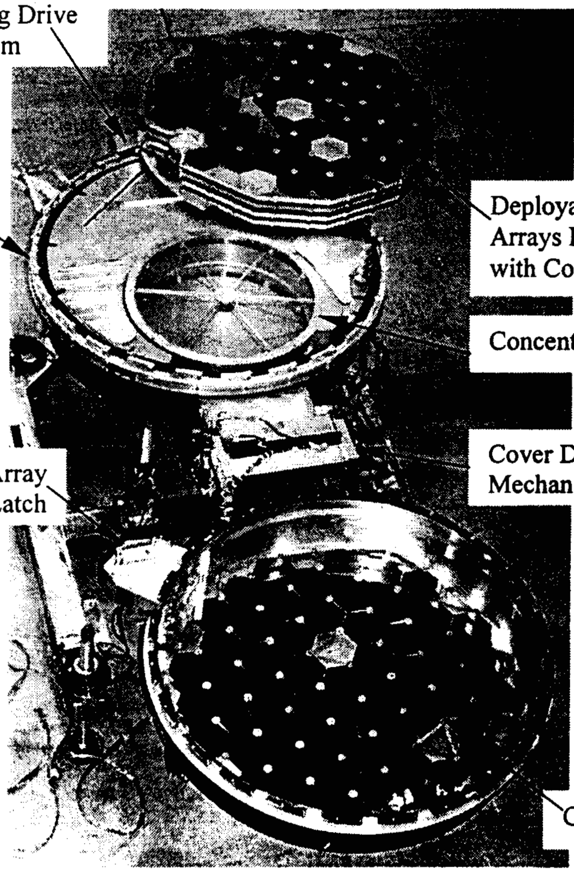
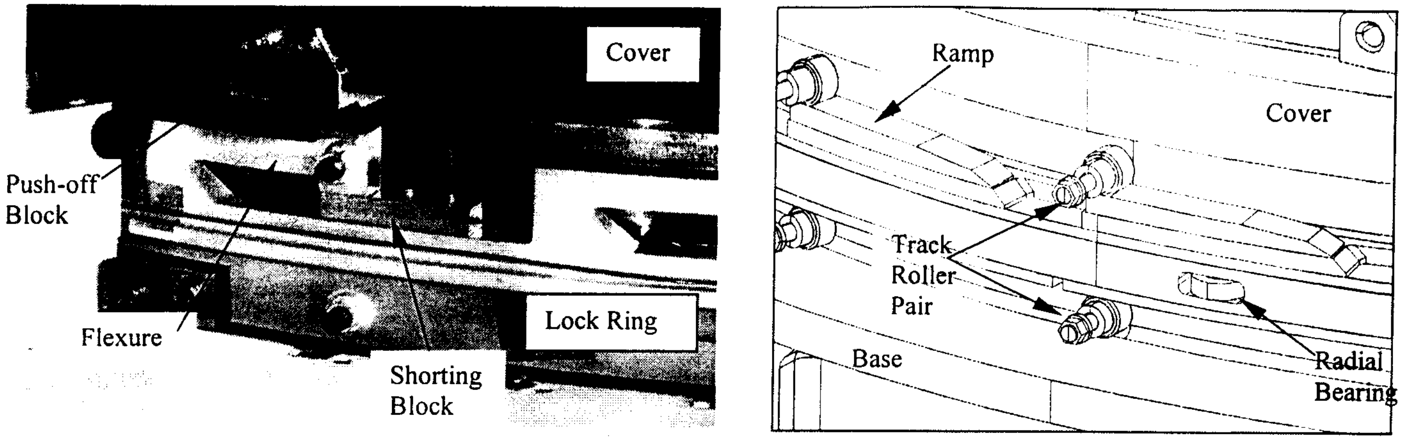


Figure 2. The Engineering Model integrated canister is shown in the open configuration.



Figures 3a and 3b. A detailed view of the Lock Ring Assembly is shown. The figure on the right has the Lock Ring removed for clarity.

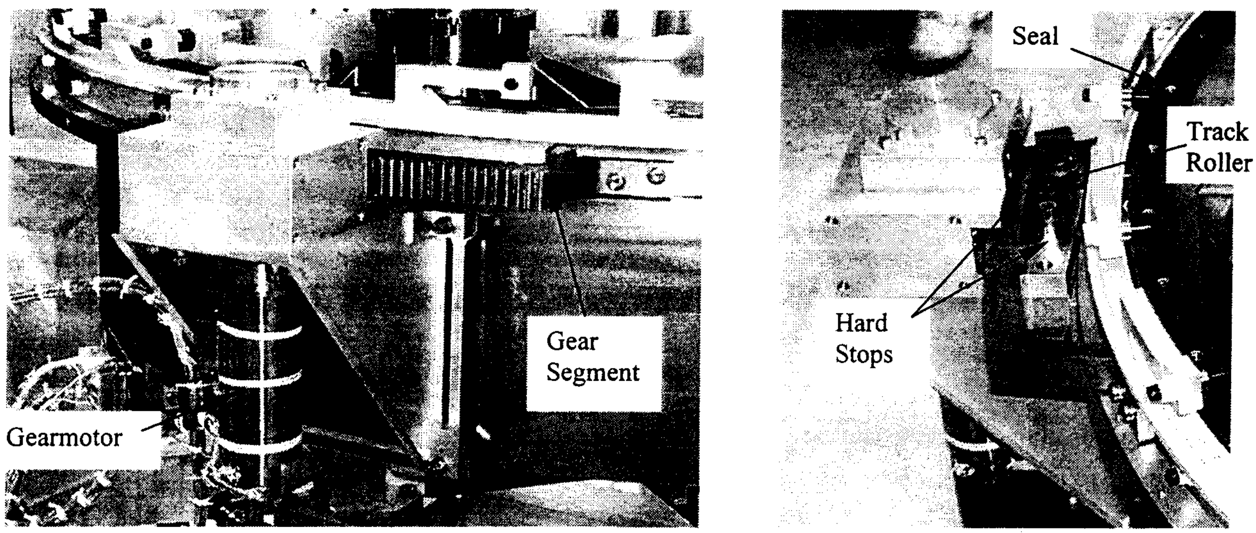


Figure 4a and 4b. The Lock Ring Drive Mechanism Assembly uses a pinion and sector geartrain to move the Lock Ring to its locked and unlocked positions.

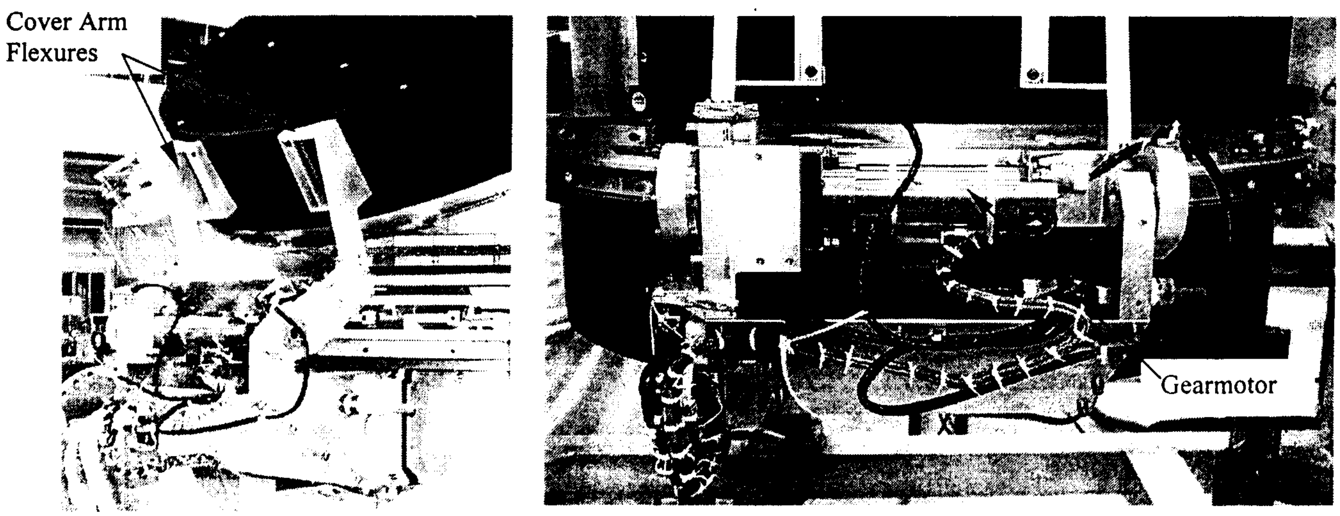


Figure 5a and 5b. The Cover Drive Mechanism Assembly opens and closes the canister cover.